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EFFECTS OF URBAN WASTES ON THE QUALITY OF ASATA RIVER IN ENUGU, SOUTH EASTERN NIGERIA

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ABSTRACT

Water samples from nine sample stations in Asata River Enugu, were analysed to determine the effects of urban wastes on the quality of the river water. Stations A- F were located in more urbanized areas of the city, while G-I were in less urbanized areas. Results of laboratory analysis show higher values of parameters(pH, turbidity, colour, conductivity, suspended solids, total dissolved solids, dissolved oxygen and biochemical oxygen demand and faecal coliform) at stations A- F than at G-I. Results of physico-chemical parameters showed values within safe limits. However, all samples failed to meet bacteriological standards. A strong degree of association was found to exist between sampling station distance from waste dump and dissolved oxygen (r = 0.88) and with total suspended solids (r= - 0.73). The study indicates that the river water quality was much lower in higher density, more urbanized areas of Enugu urban where waste generation and management is a growing problem. The study identifies the need for the development of a sustainable municipal waste management strategy that will encourage source reduction, reuse and recycling of solid wastes. The strategy will lead to the enhancement of the ecological integrity of Asata River and its tributaries.

KEYWORDS: Urban Wastes, River Water Quality, Ecological Integrity, Waste Management.

1.0 INTRODUCTION

Rivers have always provided a focus of attention for environmental studies (Petts, 1983; 1984). They offer a number of benefits and services to man and the environment, but as public goods are increasingly being polluted and threatened on a global scale by anthropogenic activities. According to Akaninwor et al, (2007), pollution of fresh water bodies such as rivers, streams, lakes and ponds is mostly experienced as a result of industrial discharge, municipal waste disposal and surface runoff. Indiscriminate and uncontrolled discharges of wastes into rivers impact negatively on river ecosystems and human health (Odukuma and Okpokwasili,1993; Kinnersley,1994; Benka-Coker and Ojior,1995; Nwachukwu and Otukunefor,2003;Ubalua and Ezeronye, 2005). An acceptable water quality is crucial in order that man can benefit from rivers by a series of uses (Sweeting,1992, Oliveira et al, 2006).

Enugu, like most other urban centres of the developing world is experiencing rapid and uncontrolled growth typified by poor planning, rapid population growth, inadequate amenities and poor sanitation (Hardoy and Satterhwaite, 1989). The rapid growth of Enugu urban has created waste management problems for the city. Asata River in Enugu urban serves as a receptacle for some of these wastes.

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Indiscriminate disposal of wastes into the river or along its channel generates concern about the ecological integrity of the river as well as the quality of the river water. At Asata, Ogui and Uwani areas of the city, wastes are dumped directly into the river.
Effluents from the University of Nigeria Teaching Hospital (UNTH), for instance have been known to be discharged into the river (Ijere, 1996). Water scarcity, a common phenomenon in Enugu Urban compels some inhabitants to make use of the river water for domestic purposes. The inability of the Enugu State Waste Management Authority to efficiently manage wastes generated within the city further compounds the problem.

The study aims at investigating the effects of urban wastes on the water quality of Asata River. The study also seeks to determine the degree of association between waste dump distance and TSS and DO concentrations in the river.

STUDY AREA DESCRIPTION

Enugu, is the administrative capital of Enugu State, South Eastern Nigeria with a population of about 722,000. The city is located between $6^0$21'N and $6^0$30N and $7^0$26'E $7^0$30'E (Fig. 1). The study area has a humid tropical climate. Mean annual rainfall ranges between 1600mm and 2,500mm (with three to four dry months), with the driest month having at least 29mm of rainfall (Umeuduji, 1993). Mean monthly temperature ranges between 27^{o}C and 29^{o}C. Vegetation type is rainforest savanna ecotone.
The main river systems (Nyaba, Ekulu, Idaw Aria, Ogbete and Asata) that drain the city originate westward from the base of the Udi escarpment and flow eastwards into the Cross River. Asata River a third order stream is a tributary of the Ekulu River and has a catchment area of about 40sqkm. The Asata river basin falls within the larger Aboine basin which is geologically made up of a variety of sedimentary rocks. Akintola (1982) noted that these sedimentary rocks which consist of sandstones and shales are generally of the cretaceous age. Specifically, the Asata River basin is underlain by the Nkporo formation (Figure2).

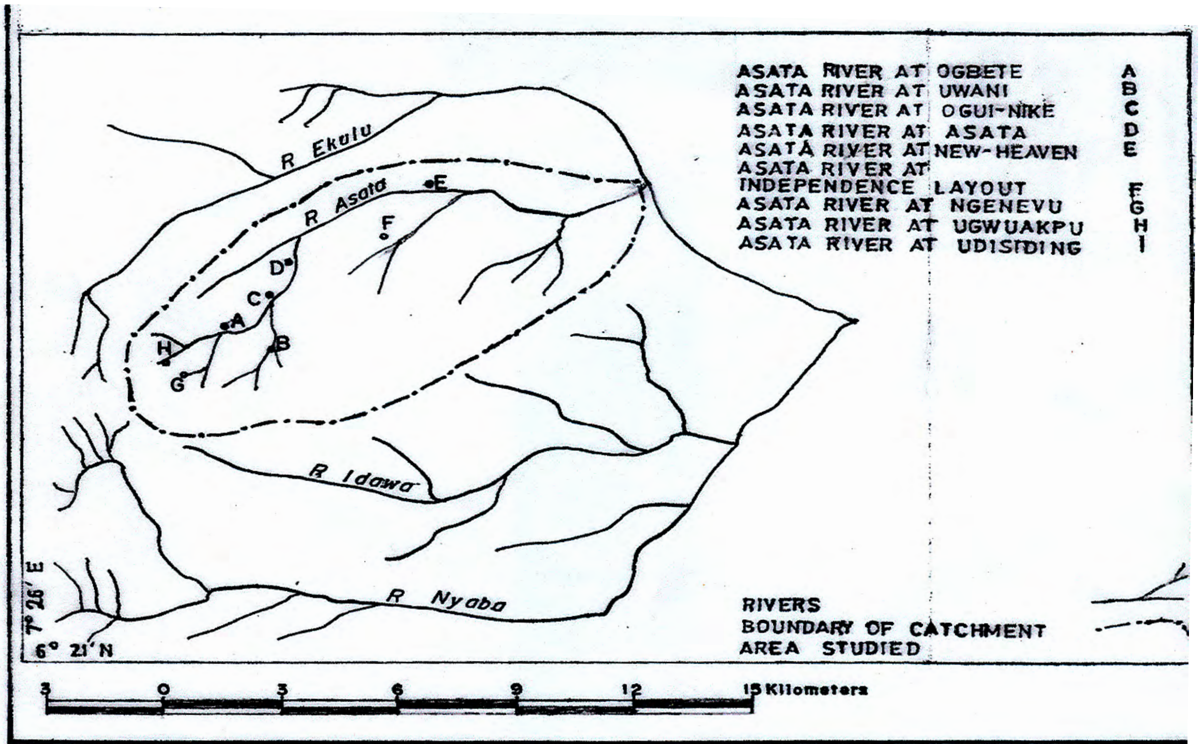

Figure 1: Location map of the study Area

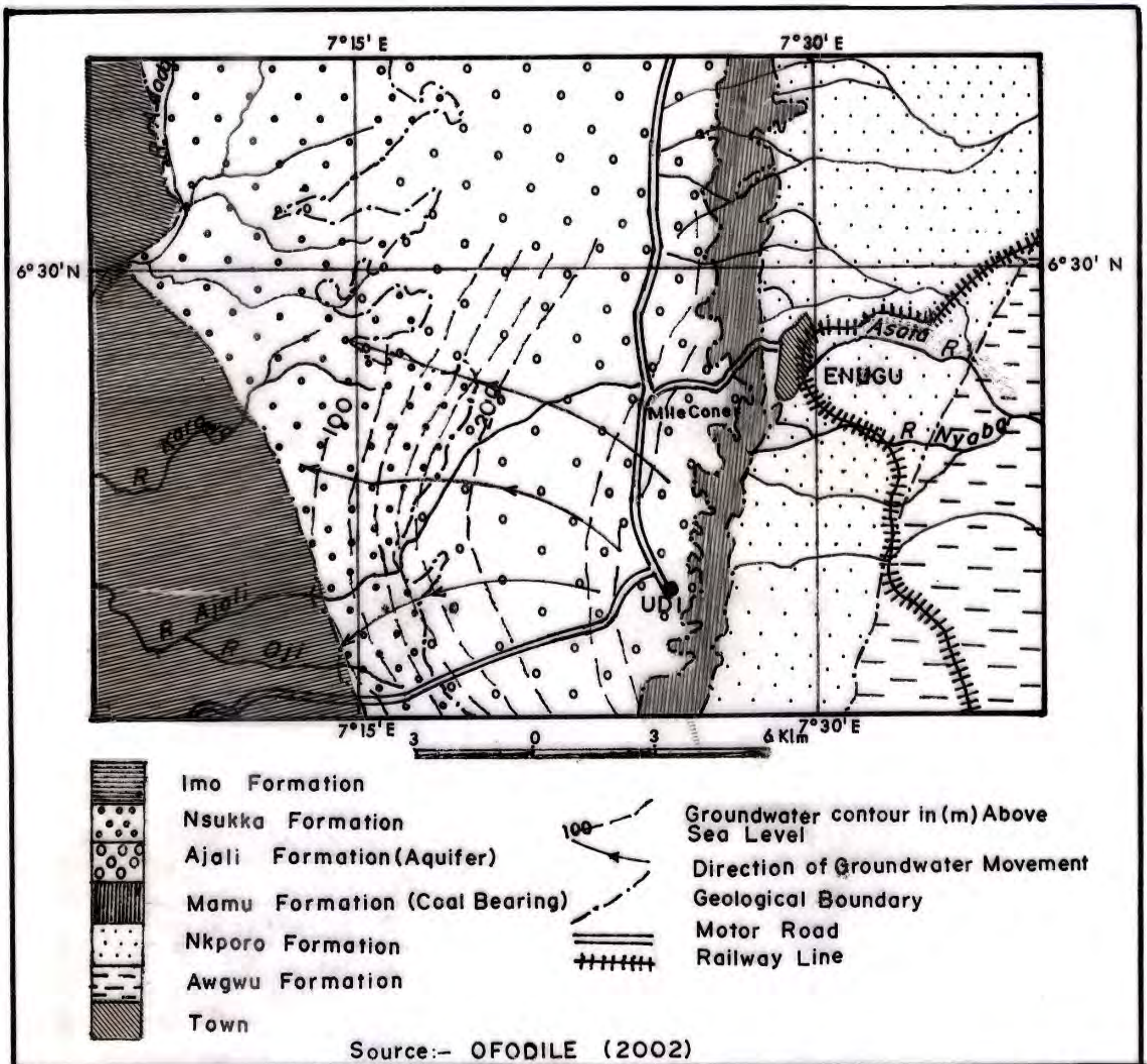

Figure 2: Geology and hydrology of the Enugu Area source:- OFODILE (2002)

3.0 MATERIALS AND METHOD

3.1 WATER SAMPLE COLLECTION

Water samples were collected once weekly for four months (Sept – December, 2005), from nine sampling stations along the river channel; Stations A (Ogbete), B (Uwani), C (Ogui-Nike) D (Asata), E (New Haven) and F (Independence Layout) are located in high density and more urbanized areas of the city. Stations G (Ngenevu), H (Ugwuakpu) and I (Udi – Siding) are in low density and less urbanized parts of the city upsteam.

For water sample collection, new clean polypropylene containers of one litre capacity were used. For ease of identification, the containers were labeled with details of sampling point and dates of collection. Samples for BOD and Do analysis were collected in air tight 60ml BOD bottles.

3.2 LABORATORY ANALYSIS OF WATER SAMPLES

Water analysis was carried out at the Water laboratory of the Enugu State Environmental Protection Agency, Enugu. Parameters analyzed were temperature, pH, turbidity, colour, electrical conductivity, dissolved oxygen, (DO), biochemical oxygen demand (B.O.D) Total suspended solids (TSS), total dissolved solids (TDS) and faecal coliform count.

Spectrophotometer was used in the analysis of colour, turbidity and TSS. For TDS, electrical conductivity and temperature, electrical conductivity meter was used. DO and BOD were analysed using digital titrator while pH value was determined with pH meter.

For total faecal coliform, 5ml of sample was inoculated into multiple tubes containing McConkey agar and incubated at 37^{o}C for 24 hrs. Production of acid and gas bubbles indicated positive presumptive test. For confirmation, two loopfuls of samples were transferred to a McConkey broth. Formation of gas bubbles and fermentation leaving empty space at bottom of inverted tubes indicated the presence of *Escherichia coli*. The sample was transferred to a Petri-dish and *E.coli* colonies developed were counted with a digital counter.

4.0 RESULTS AND DISCUSSION

Observation at waste dumps near the river showed that organic matter (vegetable and paper) and Inorganic matter (metals, plastic, polythene, glass and textile) were common in more urbanized areas (stations A-F)

The results of the water analysis of Asata River water are presented in Table 1.

Table 1: Mean quality characteristics of Asata river at Stations A - I

Unit	Temper-ature	pH	Turbidity	Colour	Conduct-ivity	TSS	TDS	DO	BOD	FCC
Sample station	0C		FTU	Ptu	ms/cm	mg/l	mg/l	mg/l	mg/l	100ml
Ogbete (A)	28.0	7.2	27	61	0.05	54	29	11.8	2.6	205
Uwani (B)	28.2	7.5	28	60	0.16	77	61	9.5	2.9	254
Ogui-Nike (C)	28.0	7.2	29	51	0.10	73	54	12.0	2.6	520
Asata (D)	28.3	7.4	26	54	0.09	50	47	9.8	2.8	391
New Haven(E)	27.8	7.2	12	32	0.07	29	45	13.1	2.4	242
I/Layout (f)	28.1	7.3	16	28	0.03	21	34	14.1	21	195
Ngenevu (G)	27.6	7.2	7	19	0.001	10	17	19.6	1.4	102
Ugwuakpu (H)	27.2	7.3	11	20	0.003	19	19	19.3	1.6	108
Udi Siding (I)	27.8	7.5	9	21	0.004	16	19	18.4	1.7	148

4.1 PHYSICAL AND CHEMICAL QUALITY

Considerable variability was observed in colour, turbidity and TSS. At stations G, H and I mean values for colour were 19 ptco, 20 ptco and 21ptco respectively. However stations A – F had values of 61ptco, 60ptco, 51 ptco, 54 ptco, 32 ptco and 28 ptco respectively. This result indicated that the less urbanized low density areas had lower concentrations than the high density urbanized areas.

Suspended solids and turbidity showed similar trend. In the less urbanized areas, TSS concentrations ranged from 21mg/l to 77mg/l while at stations G, H and I it ranged from 10mg/l-19mg/l. At G.H and I, turbidity ranged from 7Ftu to 11Ftu, while at stations A – F, the values were between 16Ftu to 29Ftu water. Temperature was also slightly lower (27.2^0C-27.8^0C) at stations G, H and I than at A – F (27.8^0C – 28.3^0C). Conductivity and TDS showed some variation. Conductivity was found to increase with increase in TDS. Values of both parameters were found to be higher at stations A – F than at G, H and I.

Dissolved Oxygen values at G, H and I were 19.6mg/l, 19.3mg/L and 18.4mg/l respectively. At stations A, B, C, D, E and F, they were 11.8mg/l, 9.5mg/l 12.0mg/l, 9.8mg/l, 13.1/mg/l and 14.1mg/l respectively. Similar trend was observed for BOD. Stations A-F had higher values for BOD A(2.6mg/l), B(2.9mg/l) C(2.6mg/l), D(2.8mg/l) E(2.4mg/l) and F(2.1mg/l). BOD values were lower at stations G, H and I, 1.4mg/l, 1.6mg/l and 1.9mg/l respectively. BOD and DO are indicative of the presence of organic pollutants in water. However, BOD did not exceed the maximum permissible limit of 5.0mg/l of WHO (1984).

4.2 BACTERIOLOGICAL QUALITY

Total coliform count for stations A-F, were 205, 254, 520, 391, 242 and 195 cells per 100ml respectively. Stations G, H and I had values of 102, 108 and 148 per 100ml respectively. The highest value of 520 cells per ml was that of station C (Ogui – Nike), a poorly planned, high density area in comparison with other areas. The presence of coliforms in water is suggestive of contamination by animal and human faeces and the likelihood of pathogens in water (Caincross and Feachem, 1983, WHO 1992). Once ingested most water borne pathogens multiply in the alimentary tract and are excreted with faeces. In areas where sanitation is poor, they enter into water bodies and infect other people (WHO, 1992). Water related diseases have been classified by White et al (1972) into water-borne (diarrhoeal diseases, enteric fevers and cholera); water-washed (trachoma and typhus fever); water based (schistosomiasis) and water related insect vectors (malaria, filariasis, yellow fever and onchocerciasis). These diseases have high morbidity and mortality rates and the population at risk, reside mostly in poor communities (Hardoy and Satterhwaite, 1989). In the study area, water borne diseases are common.

4.3 DUMP DISTANCE AND TSS AND DO CONCENTRATION

The degree of association between distance of waste dumps from Asata River at the sampling stations and the concentrations of TSS and DO was determined using the Pearson's Product Moment of Correlation Coefficient.

Table 2: DO/TSS Values at Various Locations/Distances From Dump Sites

Station	Location	Dump Distance(m)	DO(mg/l)	TSS(mg/l)
A	Ogbete	3	54	11.8
B	Uwani	1	77	9.5
C	Ogui Nike	2	73	12.0
D	Asata	5	50	9.8
E	New Heaven	400	29	13.1
F	Independence Layout	200	21	14.1
G	Ngenevu	1000	10	19.6
H	Ugwakpu	1500	19	19.3
I	Udi Siding	2000	16	18.4

Table 3: PPM computation for waste dump distance from sampling stations and DO values.

X	Y					
1	9.5	9.5	1	90.25	321363.14	21.88
2	12.0	24.0	4	14.4	326230.36	4.74
3	11.8	35.4	9	139.24	319099.58	5.56
200	14.1	2820	40000	198.81	135342.32	0.006
400	3.1	52.40	160000	171.61	28186.72	1.16
1000	19.6	196000	100000	384.16	186719.92	29.40
1500	19.3	28950	2250000	372.49	868830.92	26.23
2000	18.4	36800	4000000	338.56	205094.92	17.83
5111	127.6	93527.9	7450039	1935.1	4547558.9	126.07

X =Distance (m). Y= DO (mg/l), r = 0.88

A strong positive correlation (0.88) was established between waste dump distance from the Asata River and concentration of DO. The finding could have been strongly influenced by run off, since generally all waste dumps were upslope of the river. The result was validated by applying the t- test at 95% level of significance. Calculated t(4.88) was greater than critical t (2.365)

Table 4: PPM Computation for waste dump distance from sampling station and TSS values.

X	Y	XY	X^2	Y^2	$(X-X)^2$	$(Y-Y)^2$
1	77	77	1	5029	321363.13	146092
2	73	146	4	5329	326230.35	1171.15
3	54	162	9	2916	319099.60	231.71
5	50	250	25	2500	316844.03	125.S3
200	21	4200	40000	441	135342.32	316.06
400	29	11600	160000	841	28186.72	95.61
1000	10	10000	10000000	100	186719.92	828.17
1500	19	28500	225000	361	268830.92	391.17
2000	16	32000	4000000	256	2050941.92	518.84
511	349	84935	7450039	18673	4547558.9	5139.56

X= Distance (m), Y= TSS (mg/l), r= 0.73

Applying the PPM equation (1), a strong negative correlation (- 0.73) was found to exist between waste dump distance and TSS values. Applying the t-test at 95% level of significance, calculated t (2.807) was greater than critical t (2.365). This implies that decreasing waste dump distance from the stream is associated with high values of suspended solids.

5.0 CONCLUSION AND RECOMMENDATION

The study identifies improperly disposed wastes within the Asata river catchment as a major threat to the quality of the river water. Generally, the high density, more urbanized section of the city had pollution levels higher than those of less urbanized and less dense sections.

The physico-chemical parameters analysed were generally within safe limits in comparison with WHO (1984) criteria for river water. However, bacteriological quality was above permissible limits at all sampling stations, the highest being station C, a poorly planned high density area. A strong degree of association was also found to exist between sampling station distance from waste dump and DO (r=0.88) and TSS (r= 0.73).

This situation poses a potential danger to both human health and ecological integrity of the Asata River. The problem is largely a consequence of poor waste management at individual and community levels, poor sanitation and inadequate potable water supply, particularly at Ogbete and Ogui - Nike sections. According to Cointreau (1992), an estimated 30-50% of the solid waste generated within urban centres in developing countries is left uncollected.

Though there is increasing involvement of Private Sector Participation in waste management in Enugu, some key issues are yet to be properly addressed. A large volume of solid wastes generated, can be reduced, reused or recycled. An integrated and sustainable waste management strategy beginning with a detailed and implementable urban waste master plan for Enugu, can make the waste business more efficient and profitable for both operators and generators (Afolabi, 2006). The throw-away culture will have to be strongly discouraged. The outcome will be a safer and cleaner environment, where streams do not serve as receptacles for wastes.

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